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## ► To cite this version:

| Philippe Poinot. Jules Dupuit and the railroads: what is the role of the State?. 2012. hal-00736078

**HAL Id: hal-00736078**

**<https://hal.science/hal-00736078>**

Preprint submitted on 27 Sep 2012

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# Jules Dupuit and the railroads: what is the role of the State?

Philippe Poinso<sup>\*</sup>

## Abstract

In the nineteenth century, the emergence of railroads in France resulted in new analytical issues, as they are natural monopolies. Jules Dupuit examined the issue of the operations of the railroad sector on several occasions (1853, 1861 and 1862). He would seem to have defended two contrasting positions, opening the way for debate among commentators. In this communication, I attempt to restore the consistency of Dupuit's positions on the railroads. In the first section, I distinguish between competition as an ideal and the feasibility of competition in the railroad sector; this distinction is implicit in Dupuit's work, but it helps us to grasp that, in his opinion, unlimited competition is not possible in the railroads and that it is not necessarily beneficial to the welfare of society. The State should therefore regulate the railroad sector either by State management or through concessions. In the second section, I specify the conditions under which he believed the State should manage the railroads sector instead of offering concessions to private companies.

**Keywords:** railroads, Jules Dupuit, natural monopoly, regulation, competition.

**J.E.L. Classification:** B10, D42, L51, L92.

## 0. Introduction

Jules Dupuit always considered transportation as essential to increase the wealth of society. While he discussed all means of transport (ship canals, roads and railroads), there are three reasons for emphasizing his position concerning the exploitation of the railroad industry. First, Dupuit believed the development of the railroad industry should have important consequences for society at political, economic and social level (Dupuit, 1863a, p. 488). He even compared it with inventions such as the compass and printing (1863a, p. 484). Second, as stated by Béraud (2005a, p. 19), the emergence of railways brought with it new issues in comparison with other means of transport because they are vertically integrated<sup>1</sup>. Third, it allows us to discuss Walras' criticisms of Dupuit's position concerning the optimum

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<sup>1</sup> According to Dupuit, vertical unbundling is impossible because it implies security problems (see *infra*, section 1.2, p. 5).

mode of operation for the railroads which Walras considered to be inconsistent. On this particular point, Dupuit discussed three modes: the monopoly of a private firm, government operation and unlimited competition

On the one hand, Dupuit claimed that State management was the best way to run the railroads because “[they] are natural monopolies”<sup>2</sup> (1862a, pp. 588-9). Thus, unlimited competition is not possible in the railways (1862a, p. 589), adding that:

“Private companies are overseen... by an army of civil servants, so that we can wonder whether an industry, which can only work in these conditions, would not better be operated by State. We do not see any economic principle against this solution...” (1862a, p. 585).

On the other hand, Dupuit stated that unlimited competition is the most efficient way to operate in the railroad sector<sup>3</sup>. For instance,

“yet there would be another way to take this industry [the railroads] away from State control: it would be to acknowledge... complete competition and complete freedom. *This may be the true economic solution*” (1853a, p. 450 ; my italics).

This calls into question Dupuit’s consistency on the railroads which has never constituted the central issue of literature.

According to Ekelund & Hébert, “Dupuit... identified a natural monopoly argument with respect to the railroad” (1999, pp. 323-4). At the same time, however, they claim that:

“In a static and mechanistic style of economic theory, such natural monopoly would demand government intervention, perhaps even nationalization of the railroads, in order to prevent a loss in public utility owing to monopoly pricing – a view, in fact, that Walras... advanced. However, in Dupuit’s opinion this kind of market failure did not demand either of these ‘solutions’. Owing to locational forms of competition and the benefits of an open competitive process, wherein high profits were conducive to entry, Dupuit thought that competition in railway transportation would be no more injurious or wasteful than between butchers and bakers” (*Ibid*).

They believe that, unlike Dupuit, Walras did not understand the dynamical nature of competition: monopoly is temporary. The inefficiency of the French railway system derives from government intervention: while Dupuit “conceded that the French transport market was inefficient,... [he] attributed the cause to government intervention, not to natural monopoly” (2003, p. 670). As a result, the State should not operate in the railroad sector because unlimited competition is feasible (2012, p. 9).

In contrast to Ekelund & Hébert, Béraud (2005a), Mosca (2008) and Numa (2010) are of the opinion that Dupuit advocated State intervention in the railroad industry. Their interpreta-

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<sup>2</sup> Unless otherwise stated, translations throughout the paper are those of the author.

<sup>3</sup> Ekelund & Hébert (1999, 669, footnote no. 24) and Numa (2010, 10).

tion is based on Dupuit's assertion that the railroad industry is a natural monopoly: high fixed costs imply increasing returns to scale and, hence, a monopoly. For instance, Mosca states that Dupuit "identified the transport network as a situation in which a natural monopoly would have occurred, and that he made a first step in the elaboration of the decreasing average cost function" (2008, pp. 339-43)<sup>4</sup>. Numa concludes that Dupuit "recommended State intervention in the railroad industry showing that a public monopoly is preferable to a private one" (2010, p. 7), adding that the engineer "believes competition was the general principle of functioning of economic activity. Nevertheless he also believes that, in few industries like railroads, the facts demonstrated competition was impossible and created waste of resources" (*Ibid*, p. 10).

The aim of this article is to emphasize Dupuit's consistency on the railroad question. This consistency becomes more salient as soon as one distinguishes between two issues: unlimited competition in the railways sector and the extent of State intervention in the railroads. I will deal with these two issues successively. Dupuit considered unlimited competition as an ideal for society and for the railroads sector. However, in *Section 1*, I argue that, for he believed that competition was not feasible in his own era. In *Section 2*, I show that State management of the railroads is superior to private monopoly in the event that there is no intermodal competition<sup>5</sup>.

## 1. Dupuit's position on unlimited competition in the railroad sector

Dupuit tackled the issue of the management of railroads on several occasions:

- in his "Péages" (1853b) and "Voies de communication" (1853a) entries in the *Dictionnaire de l'Économie Politique (DEP)*;
- in two debates at the *Société d'Économie Politique (SEP)* (1853c, 1862a);
- in the *Dictionnaire général de la politique* (1863a) and *Dictionnaire universel théorique et pratique du commerce et de la navigation* (1861a);

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<sup>4</sup> See also Béraud (2005a, 15 and 20) and Numa (2010, 3).

<sup>5</sup> Dupuit never used the expression "intermodal competition". However, he developed a type of competition which is today called "intermodal competition" (see *infra*, section 2).

- and finally, in a letter written in response to Adolphe Blaise's criticisms about Dupuit's position on the fares applied by concessionaires (1862b).

Unlike certain commentators, I argue that Dupuit distinguished between two points of view when he discussed unlimited competition: unlimited competition as an ideal for society and for the operation of railroad sector (1.1) and the feasibility of unlimited competition in the railroads (1.2).

### 1.1. *Unlimited competition: an ideal for society and for the railroad sector*

In Dupuit's opinion, unlimited competition only takes place in what he referred to as "normal industries" (1862a, p. 587). Normal industries have three characteristics: they are open to any producer; wages depend on the quantity and quality of labor and the price of goods is determined by the law of supply and demand (*Ibid*, p. 584).

To understand why Dupuit considered unlimited competition as an ideal for society and for the railroads, it is necessary to specify his conception of public interest. According to him, public interest consists in achieving the goal of society. More precisely, it aims at maximizing the welfare of society under two "conditions":

- restricting as little as possible natural liberty that is the degree of liberty of individuals in the natural state (1861b, p. 636);
- protecting other natural rights<sup>6</sup>.

The welfare of society is a part of public interest and corresponds to the satisfaction of individuals' needs (Poinsot, 2011).

In any case, the optimum solution would be to maximize the welfare of the nation by ensuring the same degree of individual liberty as in the natural state. However, in practice, the legislator is forced to restrict liberty in order to increase the welfare of society and achieve public interest (Dupuit, 1863b, pp. 131-2).

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<sup>6</sup> The other natural rights which may be protected entirely by the legislator are self-ownership, self-defense and the respect of free contracts and conventions. For a more detailed examination of Dupuit's conception of public interest, see Poinsot (2010) and (2011).

If unlimited competition were feasible in the railroad industry (see *infra*, section 1.2.2), the price in a situation of unlimited competition, which Dupuit referred to as “natural price”<sup>7</sup> (1853a, p. 447), would be the norm for railway tolls<sup>8</sup>. For instance, a “natural toll is that which would result from the freedom to produce and to consume... and would leave the venal price close to the cost of transport” (1853b, p. 529). He stated the same thing in his response to Adolphe Blaise’s criticisms:

“What I wish is that railroad customers pay only the cost of transport, whether passenger or merchandise, just as they would on former means of transport if unlimited competition existed. I am very much disposed to adopt any solution that leads to this result”<sup>9</sup>.

Thus, the best way to manage the railroad industry is the system which offers the price closest to the natural price because the latter maximizes public utility (see *infra*, p. 13).

### 1.2. *Is unlimited competition in the railroad sector feasible?*

Dupuit distinguished between two questions: unlimited competition in a railway line and unlimited competition between parallel railway tracks. He focused on the latter as the former implies security problems: unlike roads and ship canals, he claimed that “on the railroads, the safety of operation requires that all the transportation expenses must be reunited and concentrated under a unique supervision. The route, the vehicle, the engine are the responsibility of the same person, who has almost a complete monopoly on transportation”<sup>10</sup>. I will therefore specify Dupuit’s position on unlimited competition between parallel tracks.

When Dupuit discussed the possibility of unlimited competition in practice, he distinguished between two questions. First, is unlimited competition good for the welfare of society in the railroad industry (1.2.1)? Second, can this kind of competition emerge in the railroads from monopolistic situation (1.2.2)?

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<sup>7</sup> Dupuit’s conception of natural price is thus different from that of Smith and Ricardo as natural price is derived from unlimited competition.

<sup>8</sup> Echoing Dupuit, I will consider “toll”, “fare” and “price” to be synonymous.

<sup>9</sup> (1862b, 597), translated by Ekelund & Hébert (2012, 5).

<sup>10</sup> (1853a, 443), translated by Numa (2010, 9). See also Dupuit (1863a, 479-80). As Numa (2011, 4) noted, the problem of security was a common argument at this time. Two of the largest accidents in the nineteenth century occurred at Melun on May 8, 1842 due to fire and on the Northern line on July 8, 1846 as the result of a mudslide. For more information, see Caron (1998).

### 1.2.1. Dupuit's hesitations on the virtue of unlimited competition in the railroad industry

Dupuit's discussion on the virtue of unlimited competition in the railroads can be found in "Péages" (1853b) and "Voies de communication (I)" (1853a) in the *DEP* and in a debate at *SEP* concerning monopoly in the railroad industry (1853c). He assumed two opposite positions: on the one hand, in "Péages" and "Du monopole des chemins de fer", he denounced the negative consequences of unlimited competition for society. On the other hand, in "Voies de communication (I)" (1853a), he presented unlimited competition as the most efficient means of managing the railroads and increasing the welfare of society.

In "Péages", Dupuit claimed that unlimited competition is harmful to the wealth of society, adopting the following rationale: imagine a firm with monopoly power which yields extra-profit. A new firm wishes to enter the market. If, however, this were to occur, it would diminish the revenue of the entering firm while also decreasing the revenue of the incumbent. So, in Dupuit's opinion, "the new company would have significantly harmed the incumbent one...; instead of one good deal, there would be two bad ones" (1853b, p. 520)<sup>11</sup>.

In "Voies de communication (I)" (1853a), he claimed that unlimited competition in the railroad industry increases the welfare of the nation: "with regard to the building of railway tracks and means of transport, complete competition and freedom is the true economic solution" (1853a, p. 450, I translate). Unlike his contemporaries<sup>12</sup>, Dupuit affirmed that unlimited competition in the railroad industry would not create a greater waste of resources for the nation than in any other industry. In reference to the example of the two companies operating a service between Paris and Versailles (one *via* the left bank and the other *via* the right bank), he claimed:

"A rival company builds a second, manifestly parallel [line]. As a result, the nation loses a capital nearly equivalent to the value of the latter's track. The two railroads from Paris to Versailles exemplify the consequences of unlimited competition in railroad construction. It must be acknowledged that this causes a serious disadvantage; but, to our way of thinking, it is much less than what happens under monopoly, and perhaps even less than the consequences of State operation. It is largely unnoticed that this disadvantage, which made such a powerful impression when these lines were being constructed, is present in all kinds of industry. It is quite evident that the parceling out [of business] among a large number of vendors raises enormously the capital necessary for production to take place, which is more than occasionally lost, causing costs to multiply. Walking the streets of a major city, for example, we are struck by the proximity of one tailor next to another, one cabinet maker be-

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<sup>11</sup> [(1853b), p. 520].

<sup>12</sup> The engineers of *Ponts et Chaussées* and of the *Mines* worried about the profitability of these railway tracks. See Breton & Klotz (2009, 451, footnote no. 54).

side another... To what advantage? One of the two is evidently sufficient to satisfy the public need..."<sup>13</sup>.

And he concluded that "unlimited competition, regarding the means of transport, would not cause more disadvantages than it would elsewhere" (*Ibid*, pp. 451-2).

Dupuit's position on the virtue of unlimited competition is thus ambiguous. This is not problematic for the purposes of this article as he assumed that unlimited competition was impossible in the railroad sector in France during his time.

#### 1.2.1. *Unlimited competition cannot emerge from a monopolistic situation in the railroads*

Dupuit stated that railroads are monopolies (1863a, p. 480) and that State intervention is necessary in order to limit the harmful consequences of monopoly, but "when railway operations are subjected to the law of competition, there will be no reason for State intervention..." (1862a, p. 587) adding:

"It would be a happy occurrence if we were to find a means of eliminating some of the disadvantages facing companies which result from a monopolistic situation and to find a way of stimulating competition" (*Ibid*).

In order to clarify his position, Dupuit differentiated three kinds of industry in society: normal industries, collective industries and industries which are "necessarily monopolies" (*Ibid*, pp. 584-5). Three characteristics make them different: the capital to produce goods, the way workers' wages are set and the degree of competition in the market.

As mentioned above (see p. 4), in normal industry, there are no barriers to entry, workers are paid according to their work and the price of goods is determined by the law of supply and demand. In these industries, government intervention is not required because:

"The State can only produce with workers whose salary... is proportional neither to the quality, nor the quantity of products. As these workers are not stimulated by personal interest, which is the most powerful rationale in ordinary acts of life, they would produce much less than free workers [whose] wage [depends] on merit and the quantity of individual work" (*Ibid*).

Conversely, collective industries (i.e. ironworks, credit industry) need huge capital (1862a, p. 584) and workers are in the same position as civil servants because "their wages are fixed

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<sup>13</sup> (*Ibid*, 451-2); translated by Ekelund & Hébert (2012, 8).



and independent of their work" (*Ibid*)<sup>14</sup>. Consequently, it is impossible "to invoke against State management of collective industries the argument of personal interest" (*Ibid*). However, as private companies are in competition with each other, the State is less efficient than private firms. Dupuit used three arguments to justify his position. First, unlike in the case of public management, competition stimulates firms "to satisfy users' tastes" (*Ibid*). Second, in contrast to civil servants, workers in collective industries can be laid off due to firm bankruptcy: indeed, a "forge, a mine, a badly managed bank soon go bankrupt and so all their workers lose their wages" (*Ibid*). Third, firms in collective industries are price takers: "the price of their services is set by the law of supply and demand, and the consumer cannot complain" (*Ibid*). Consequently, "if the State were to operate a forges or bank, it would experience no rivalry; as a result, its production would be worse than these big companies" (1862a, p. 584). Thus, government intervention is not necessary in collective industries.

Dupuit identified a third type of industry requiring huge capital and in which workers' wages are set independent of their work. Unlike collective industries, firms in these industries can set a monopoly price:

"the situation is different for some industries, i.e. railroads, because they are inevitably monopolies. On the one hand, their workers... are not concerned by the result of their works as they are in the collective industries; and, on the other hand, they are not worried... by users' needs because consumers cannot use other means of transports" (*Ibid*, pp. 584-5).

Dupuit named these industries "natural monopolies" (*Ibid*, p. 587)<sup>15</sup> in contrast to "artificial monopolies" (*Ibid*). While artificial monopolies (*Banque de France, Crédit Foncier, Crédit Agricole...*) arise from law, natural monopolies derive from the "nature of things". As a result, the "drawbacks of artificial monopolies are easy to break, as it is simply a question of eliminating the monopolies themselves. This solution cannot be applied to natural monopolies" (*Ibid*, p. 589).

In a previous debate at *SEP* (1853c) and in his article "Péages" in the *DEP* (1853b), he clarified that competition cannot emerge in the railroad industry because of the existence of barriers to entry in this sector. He mentioned two kinds of barrier to entry: the high level of fixed costs in absolute value and the inherent advantages of the incumbent.

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<sup>14</sup> Dupuit made the same point in his review of Molinari's book, *Question d'économie politique et de droit public*. See Dupuit (1863b, 128-9).

<sup>15</sup> According to Dupuit, natural monopolies include the railroads, gas distribution, water distribution, telegraph, etc. See Dupuit (*Ibid*, 588-9).

First, Dupuit considered fixed costs in two ways: in relative value and in absolute value<sup>16</sup>. While, in the railroads as well as any kind of industry, fixed costs correspond to  $\frac{3}{4}$  of annual expenses (*Ibid*, pp. 528-9), they are, in absolute value, much higher in the railroads than in any other industry. This implies barriers to entry because “once a firm is established with a capital of 40, 50 or 100 million, etc., no rival companies... can be set up, because this sum of money is always difficult to collect...” (1853c, p. 574). Building a new infrastructure is [thus] limited to a small number of people (1853b, p. 520).

Second, even though firms have enough capital to build parallel railroads, Dupuit added that “as the incumbent company is the only one within the market, the new one cannot compete with the first one, and the profit made by one is not enough for two”<sup>17</sup>. As stated by Mosca (2008) and Numa (2010), the first firm always has advantages on the choice of the road, clientele habits, and so on:

“it is highly possible that the first company which had to choose the route, chose the best one... therefore your route is necessarily inferior in terms of land quality, wealth, population, etc. Then you arrive after clientele habits, established relationships; you can only hope to take the half of the clientele of the incumbent company [which insure law benefits to the entering firm]...”<sup>18</sup>

The railroad industry is thus a “de facto monopoly” (1853b, p. 519): the railroads “whose construction and operation need tremendous expenses are necessarily monopolies, and the proprietor of... a monopoly can draw a revenue from it that is superior to that of capitals submitted to competition”<sup>19</sup>. Nevertheless, this situation may change in the future with the evolution of technology: some sectors of the economy in which unlimited competition was feasible in the past became natural monopolies through the technological revolution. For instance:

“When public lighting was oil lighting, competition was unlimited; with gas, which required burying the gas pipe, public lighting became a monopoly. The evolution of some industries change their own nature and we have to accept the consequences in terms of management” (1862a, p. 588).

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<sup>16</sup> This distinction has not been made by Béraud (2005a), Mosca (2008) and Numa (2010). However, it is important as it is the only way to understand the two subsequent statements by Dupuit: on the one hand, fixed costs are in the same proportion in every industry and, on the other hand, fixed costs are higher in the railroad sector than in every other industry.

<sup>17</sup> (1853b, 520); translated by Numa (2010, 7). The same argument was used by Dupuit for another natural monopoly: the water supply network. See (1852, 540).

<sup>18</sup> (1853b, 520); translated by Numa (2010, 7-8). See also Dupuit (1853c, 574).

<sup>19</sup> (*Ibid*, 520); translated by Numa (2010, 7).

Dupuit assumed that the opposite could be true for railroads: so, in the future, unlimited competition could be possible in the railroad sector. In his own time, however, the barriers to entry prevented such competition.

According to Dupuit, two other operating modes were possible for the railroads: private monopoly and State monopoly (Dupuit, 1853a, p. 446). I will now explain which of these two modes of management Dupuit believed was the most efficient to operate the railroad sector.

## **2. State management vs. Private monopoly**

When Dupuit dealt with the issue of the best way to manage the railroads, he seemed to make a comparison between concessions and State management. This is not surprising in light of the era he lived in. Between 1823 and 1832, railroad concessions could not transport passengers but could only build and operate goods transport networks, in particular for coal. While government intervention was kept to a minimum with regard to financial assistance and the exploitation of railway lines, State grants perpetual concessions. In 1833, the government began to control the concessionaires for the development of passenger transport: on April 26 1833, concession length was reduced to 99 years and a maximum legal fare was created to control the fare applied by concessionaires<sup>20</sup>.

However, Dupuit's arguments could be applied to concessionaires with maximum legal fare as well as non-concessionaires private companies. For instance, as I will show, the main disadvantage of a monopoly is the toll rate applied by a private firm seeking to maximize its revenues. The only divergence between the concessionaire and the private company is that, even though a higher toll rate increases its revenue, the former only equates its price to the maximum legal fare. So, in this article, I use the term "company" to speak of concessionaire as well as non-concessionaire private company.

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<sup>20</sup> For more detailed information on the development of the railroads in France, see Caron (1997) and Numa (2009, 107-12; 2010, 4-6).

Unlike the French liberals of the nineteenth century<sup>21</sup>, Dupuit believed that the decision on whether to support government intervention in the economy should be based on an impartial criterion: public utility. State management is required when it increases the quantity of wealth for society more than any other kind of management. While public utility is the only public decision-making principle, it leads to various solutions according to time and space (1861b, p. 633)<sup>22</sup>. In accordance with public utility, Dupuit offered various answers to the issue of how best to run the railroads<sup>23</sup>. In particular, he distinguished between railway lines in which there is intermodal competition (2.1) and railway tracks in which there is no intermodal competition (2.2).

### *2.1. A State-operated system is superior to private monopoly in the event of no intermodal competition*

Dupuit identified two cases in which there is no intermodal competition.

When speed is the most important characteristic in the choice of the means of transportation as for passenger (1863a, p. 480) and perishable freight, the railroads enjoy a huge advantage over roads and ship canals (1861a, p. 472).

Although the cost of transportation is the criterion to choose the means of transportation, there can be no alternative choice for merchants to transport non-perishable merchandise between two places. Imagine “I wish to transport merchandise from Paris to Lille, I have to pay the railway company toll, because there is no other choice” (1853b, p. 519).

For these cases, comparison between the exploitation by the State and by a private company is based on two dimensions: fares applied to users (2.1.1) and the efficiency of the organization structure (2.1.2).

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<sup>21</sup> For the conception of State intervention by French liberal economists, see Silvant (2010).

<sup>22</sup> For more details on the criterion of public utility, see Poinso (2011, 356-74).

<sup>23</sup> Traditionally, the secondary literature claims that the “pragmatic” approach of Dupuit was in complete contrast to the ethical and ideological approach of Léon Walras since the latter justified State intervention in the railroad industry according to the notion of *service public*. For more information, see Béraud (2005a), Ekelund & Hébert (2003) and Numa (2010).

### 2.1.1. Uniform price versus price discrimination

For Dupuit, the issue of operating the railroads was how to finance the railway tracks. As with any transportation infrastructure<sup>24</sup>, the only method conforming to ethical justice (Poinsot, 2010, pp. 807-9) is for railway infrastructures to be financed by users:

"nobody can dispute the just character of the tax [that charges those who benefit from it], not even those who pay for it. In fact, it is obvious that if they did not find a certain advantage in using it, in spite of the toll, then they would not use it. Nothing justifies charging those who do not use this means of communication..."<sup>25</sup>

When price discrimination is not applied by the railway's owner, government operation is more efficient than private monopoly. The State seeks to maximize the public utility of the infrastructure whereas a private company wants to maximize its revenue:

"In price setting, two points of view are possible. In the case of a private company, it would obviously seek to obtain the highest revenue... If it is the State that exploits the industry, as it is likely that it will want to cover the interest of capital borrowed and the maintenance costs, it would charge a much lower rate than company. The lower the toll, the more users there are and the more the means of transportation is useful"<sup>26</sup>.

A government wants "a fixed sum of money covering the interest of capital borrowed for construction, maintenance costs and, if possible, a provision for depreciation" (1844, p. 280). As the demand function is given by  $Q = f(p)$  (*Ibid*, p. 240)<sup>27</sup> with  $Q$  the quantity transported and  $p$  the toll, so, according to Dupuit, the State solves equation [1] (*Ibid*):

$$[1] \quad M = pf(p)$$

with  $M$  representing construction costs and the interest on the capital borrowed.

A private company wishes to maximize its revenues, which means that it will solve equation [2] (*Ibid*):

$$[2] \quad f(p) + p'f(p) = 0$$

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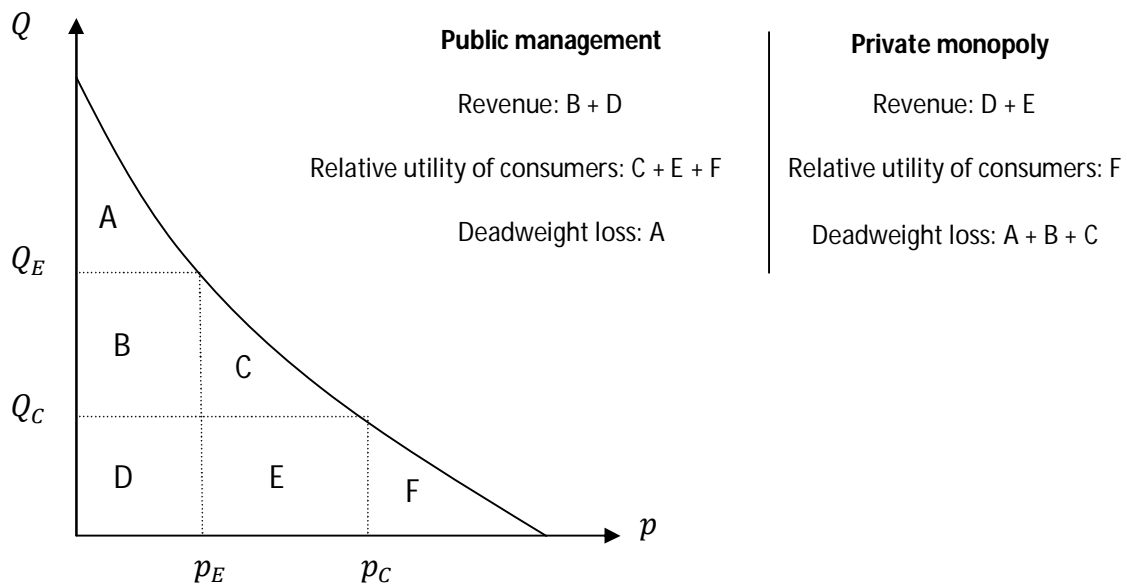
<sup>24</sup> Dupuit only recommends taxing all members of society (users and non-users) for roads because 'the State only charges directly for services that it provides when this can be achieved fairly and economically' (Dupuit 1865, 533). He nevertheless adds that 'theoretically, a traffic toll applied to roads would be fair and just' (*Ibid*).

<sup>25</sup> Dupuit (1853d, 457-8). See also (1865, 533).

<sup>26</sup> Dupuit (1853b, 524). See also (1849, 279-80; 1853c, 575).

<sup>27</sup> For more information on the construction of demand function in Dupuit's thought, see Béraud (2005b), Daniel (1971), Diemer (2003), Ekelund (2008), Ekelund & Gramm (1970), Ekelund & Hébert (1999) et (2002), Houghton (1958), Poinsot (2011, 361-70), Pfouts (1953, 316), Siroën (1995, 36-41) and Stigler (1950, 313-4).

Suppose (Graph 1<sup>28</sup>) that  $p_E$  is the solution to [1] whereas  $p_C$  solves [2].  $M$  equals  $B + D$  and the revenue of the private company is the area  $D + E$ . The relative utility of consumers – which is the difference between users' reserve prices (or, what Dupuit referred to as the absolute utility of the individuals) and the market price – is higher in the case of public management (area  $C + E + F$ ) than private monopoly ( $F$ ). Deadweight loss is lower for public management (area  $A$ ) than the private firm ( $A + B + C$ ). In comparison with a private monopoly, public management increases the absolute utility (or the public utility) of the infrastructure – the sum of the owner's revenue and the relative utility of consumers – by  $B + C$ .



Graph 1: Variation of deadweight loss between public management and private monopoly

With uniform price, a natural monopoly should be managed by State.

However, according to Dupuit, uniform price is not the optimum system of taxation. In order to compare different modes of taxation, two dimensions are considered:

- i. Does the type of taxation enable construction costs and capital interest to be paid?
- ii. What is the best mode of taxation to maximize public utility? In other words, what is the fare system which enables all individuals to use the infrastructure?

The second level may seem surprising for modern economists. What was important to Dupuit was not consumers' surplus but the public utility of infrastructure: a method of taxa-

<sup>28</sup> Echoing Dupuit, I will put  $Q$  on the y-axis and the fare ( $p$ ) on the x-axis.

tion which does not prevent any individual from using the infrastructure is better than any other method of taxation, whatever the consumers' surplus are.

While he considered that a uniform price which repays construction costs and capital interest is equal to price discrimination in terms of  $i$ , Dupuit was in favor of the latter because public utility is higher with price discrimination than uniform price. For instance, he rejects uniform price between different railway lines since each line has its own utility (1853b, pp. 528-9). He also criticized tolls to protect industries and mileage taxation<sup>29</sup>.

According to Dupuit, optimum taxation was perfect price discrimination in order to maximize public utility: the "skill of the operator is thus to set the maximum price for any passenger and any merchandise that would lead them to use the railway track" (Dupuit, 1863, p. 481).

While perfect discrimination alone is an ideal, this is the kind of taxation which should be sought by the owner of a road. He should differentiate between consumer categories, set various prices according to the users' elasticity of demand (Ekelund & Hébert, 1999, p. 195 ; Mosca, 1998)<sup>30</sup> and use spatial discrimination<sup>31</sup>. Suppose (Graph 2, p. 15) for instance that the railway owner distinguishes between three categories of user: first-class users have to pay the price  $p_1$  to use the infrastructure whereas second-class and third-class users pay  $p_2$  and  $p_3$  respectively. There are  $Q_1$ ,  $Q_2$  and  $Q_3$  users in first, second and third class. Compared to uniform price ( $p_E$  in Graph 2), the revenue of the railway's owner increases by  $B + I$  and the deadweight loss decreases by  $B + C$ . So the public utility of the infrastructure increases with regard to uniform price<sup>32</sup>.

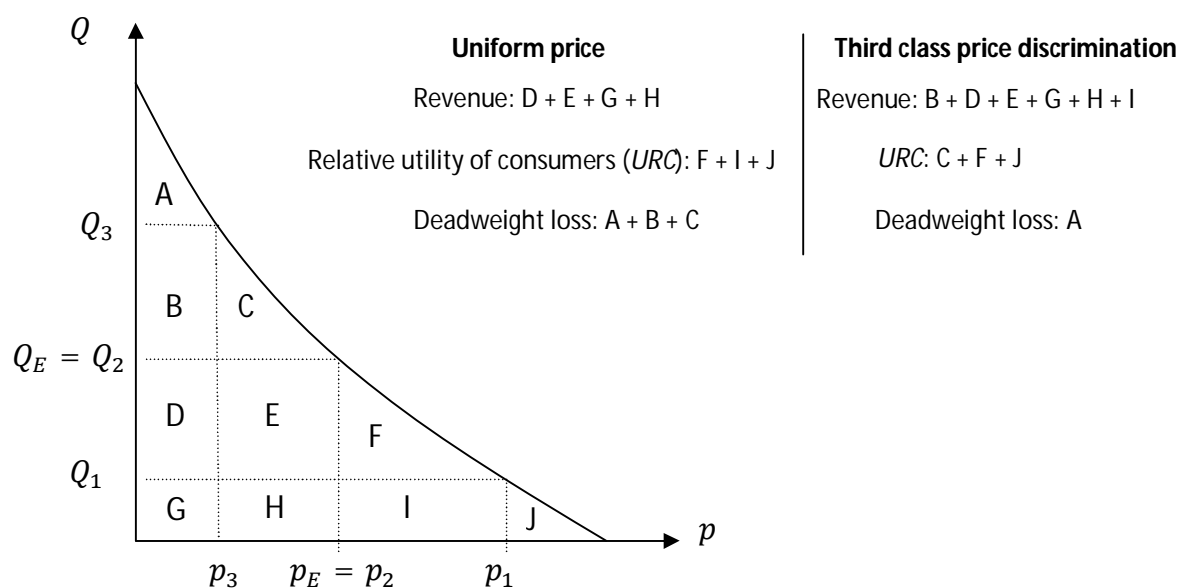
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<sup>29</sup> See Béraud (2005a, 21) and Ekelund & Hébert (2003, 670).

<sup>30</sup> Dupuit advised the operator to charge higher tolls on captive consumers.

<sup>31</sup> See Diemer (2000), Ekelund & Hébert (1999, 259-61), Ekelund (1970) and Ekelund & Shieh (1986).

<sup>32</sup> The result is ambiguous for the relative utility of consumers. In our example, price discrimination will only decrease the relative utility of consumers if  $I$  is larger than  $C$ .



Graph 2 : Comparison of deadweight loss between uniform price ( $p_E$ ) and third class price discrimination ( $p_1, p_3, p_E$  for the consumers of the first, second and third class)

As price discrimination increases the owner's revenue, the private company, as with the government, should prefer it to uniform price. Although Dupuit did not state it, he was indifferent between State management and private monopoly in the situation of price discrimination. However, he seemed to prefer government management, indicating arguments which were not based on tariffs.

### 2.1.2. Civil servants are more efficient than "private servants"

According to Dupuit, the State is better organized<sup>33</sup> than a private company because civil servants are more efficient than workers in a private monopoly, which can also be referred to as "private servants". For instance, he claimed that:

"economists' arguments to refuse State management of the majority of industries cannot be applied to the railroad industry. When a producer... earns a wage corresponding to his product quality and quantity, he provides good work and produces as much as possible, whereas he works... as little as possible when, as a civil servant, he earns a fixed salary... In the railroad industry, all workers earn fixed wages and they are not interested in the welfare of the company any more than civil servants are of the welfare of the State" (1863a, p. 482).

And he added that "the workers of a company... are a kind of civil servant; from the lengthman who straightens the tracks to the director who manages the operations, the only incentive to stimulate their natural laziness is their conscience" (1853a, p. 448). Dupuit of-

<sup>33</sup> According to Dupuit, the only advantage of a private company over State ownership relates to the choice of route, because political considerations have no impact on companies' choice (1863a, 482).



ferred two arguments to justify his position: the State's organization against the laziness of civil servants and civil servants' desire to serve society:

"Society has taken special and numerous precautions against the indifference, laziness and lack of integrity of civil servants. Although less powerful than personal interest, considerations resulting from the honor of serving the State are motives which have an impact which cannot be overlooked" (*Ibid*, p. 449).

Moreover, unlike the workers of a private company, the work of civil servants is better controlled by the press and citizens: "public opinion and the press have some control over civil servants which does not exist for the workers of companies because the latter are seen as private producers criticism of whom would seem to be slanderous"<sup>34</sup>.

Thus, government management of a natural monopoly is more efficient than a private monopoly for railway lines where there is no intermodal competition. Dupuit's conclusion on railway tracks where there is competition from roads, ship canals or other railway lines was somewhat different.

## *2.2. Private monopoly is superior to State management in case of intermodal competition*

In his letter reproduced in *Journal des Économistes*, Adolphe Blaise (1862) criticized Dupuit because, according to the former, railroad concessionary companies do not set prices equal to the maximum legal fare. According to Dupuit, this is only right for railway tracks transporting non-perishable goods because there is intermodal competition. In the case of non-perishable freight, the choice of transportation is based on transport cost: since speed is not relevant, the railroads lose their advantage over roads and canals. Intermodal competition forces the railway line's owner to set a low price: "If railway companies set their prices, in certain circumstances, below the legal price for merchandise, this is solely the result of competition from other means of transport" (1862b, p. 595). In other words, there is no point in the railway track owner setting a high price because freight transport is intermodal (Ekelund & Hébert, 2003, p. 670): high tolls lead merchants to use either other means of transport or other railway tracks. However, Dupuit explained that Blaise's assertion was wrong when he claimed that it demonstrated that company interests coincided with consumer interests: the railway line's owner always set his price to maximize his revenues.

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<sup>34</sup> (1863a, p. 483). See also Dupuit (1862a, 586).

Thus, the owner of a railway track in which there is intermodal competition sets his prices below the maximum legal price. This will lead him to set different prices according to the freight transported and the degree of competition. I believe that the situation for these railway tracks is the same as collective industries. As a result, government intervention is not required.

In brief, the State should operate railway lines in the event of intermodal competition (passengers and perishable freight) whereas its intervention is not required for railway tracks where there is competition from either other means of transportation or other railway lines. While Dupuit tackled the issue of mixed railway tracks (transport of passengers and freight) from the point of view of taxation, he did not discuss the most efficient way to manage them. Nevertheless, in “Voies de communication”, he concluded that “every transport means that is a monopoly should be controlled by the State, and every transport means that is accessible to competition should be operated by private industry”<sup>35</sup>.

### 3. Conclusion

I have emphasized Dupuit’s consistency on the railroads issue. Unlike the secondary literature, I show that he did not give exclusive answer to the problem of operating railroads. Dupuit’s position on the railroads was similar to the contemporary literature on railways on two points. First, one cannot adopt an *a priori* position on operating railroads: economists should take account of the characteristics of the economy considered. As a result, Dupuit did not oppose State management and competition. Second, the characteristics of a natural monopoly of the railroads are not sufficient as a basis for Government control. It would depend on the existence of intermodal competition: State management is only required for railway tracks where there is no intermodal competition whereas management by private companies is the most efficient way to operate railways in the event of intermodal competition.

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<sup>35</sup> (1853a, 452); translated by Numa (2010, 10).

The issue of the railroads serves as an excellent example of how Dupuit considered the function of government in society. In line with the French liberals of the nineteenth century, he argued that the optimum solution is unlimited competition. Unlike them, however, he considered that State intervention is necessary to increase the welfare of the nation. With regard to property rights, for instance, Dupuit distinguished between land property and intellectual property rights. While property rights over land should be individual, intellectual propriety rights should be managed by the State: his rationale consisted in stating the superiority of unlimited competition and then to stress the special features of intellectual property rights which led him to defend State intervention for intellectual works (pictures, books, etc.) and inventions. First, he presented two arguments to justify why individual appropriation of land is better than collective appropriation: first, agricultural output is higher for the former than for the latter, as it stimulates self-interest; second, individual propriety rights over land increases the intellectual satisfaction of the property owner and his sense of responsibility (Dupuit, 1861c, pp. 611-2). Then, he considered that, unlike land, intellectual works and inventions demonstrate the characteristics of what modern economists refer to as public goods: thus, Government intervention is required. In Dupuit's opinion, the optimum solution would consist in passing works into the public domain, but there would be no incentive to create and innovate. Copyright and patents are necessary to give creators and innovators an incentive. As for the railroads, Dupuit distinguished between the case of intellectual works and inventions: the duration of copyrights should be lower than that of patents because invention is a cumulative process (1861b, pp. 629-30). Moreover, Dupuit claimed that the duration of patents should depend on the sector and should vary according to time and space (*Ibid*, pp. 632-3).

Thus, according to Dupuit, it is impossible to assert unequivocally that one sector should be operated by State. The scope of government intervention should be determined according to the criterion of public utility. The economist has to look at the conditions of society which means that the solution depends on the technological, social and economic conditions of society and on the characteristics of the goods.

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